Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (Currently Amended) A haptic interface device to provide haptic interaction to a user manipulating a tool, the haptic interface device comprising:

an attachment point;

a first, a second, a third, and a fourth cable, each having a first and a second end, ~~the first end,~~ and each coupled at respective first ends to the attachment point;

a first, a second, a third, and a fourth tool translation effecter device positioned, relative to each other, such that each of the first, the second, the third, and the fourth tool translation effecter devices occupies a vertex of a tetrahedron, each having coupled thereto the second end of a respective one of the first, the second, the third, and the fourth cables such that, as the attachment point moves, each of the first, the second, the third, and the fourth cables is retracted or paid out accordingly by the respective tool translation effecter device, each tool translation effecter device including controlling means for selectively varying an active tension on the respective cable;

metering means for metering each of the first, the second, the third, and the fourth cables as they are retracted and paid out; and

calculating means for calculating a force response to be applied to the attachment point at least in part on the basis of a position of the attachment point, as determined by a distance between each of the first, the second, the third, and the fourth tool translation effecter devices and the attachment point.

2. (Previously Presented) The haptic interface device of claim 1 wherein:

the controlling means of each of the first, the second, the third, and the fourth tool translation effecter devices includes a spool and a motor coupled to rotatably drive the spool, the

motor and spool selectively operable to wind and unwind the second end of the respective cable; and

the metering means includes:

counting means for counting fractions of rotations of the spool of each of the first, the second, the third, and the fourth tool translation effecter devices; and

compensating means for compensating for a change in ratio between changes in distance from each tool translation effecter device to the attachment point and angular rotation of the respective spool.

3. (Previously Presented) The haptic interface device of claim 57 wherein the establishing means includes a controller configured to direct the first tool translation effecter device to retract, during an initialization procedure, the first cable until the attachment point is at a selected position relative to the first tool translation effecter device.

4. (Previously Presented) The haptic interface device of claim 58 wherein the establishing means includes respective brakes configured to lock each of the first, the second, the third, and the fourth tool translation effecter devices when electric current is removed therefrom, and a memory configured to receive and store, after current is removed from the brakes and prior to a complete shutdown of the device, the respective distances between each of the first, the second, the third, and the fourth tool translation effecter devices and the attachment point, and to provide the stored distances during a startup procedure.

5. (Previously Presented) The haptic interface device of claim 57 wherein the establishing means includes a sensor configured to sense, independent of the first tool translation effecter device, a position of the attachment point relative to the first tool translation effecter device.

6. (Original) The haptic interface device of claim 5 wherein the establishing means includes means for reestablishing the distance from time to time during operation.

7. (Previously Presented) The haptic interface device of claim 1, further comprising:

a sensor array at the attachment point configured to provide signals corresponding to an orientation of the attachment point.

8. (Original) The haptic interface device of claim 7 wherein the sensor array is configured to provide signals corresponding to roll, pitch, and yaw of the attachment point.

9. (Previously Presented) A haptic interface device to provide haptic interaction to a user manipulating a tool, the haptic interface device comprising:

an attachment point configured to receive the tool;

a plurality of not more than four cables, each cable coupled at a respective first end to the attachment point; and

a plurality of tool translation effecter devices, each having coupled thereto a second end of a respective one of the plurality of cables such that, as the attachment point moves relative to that tool translation effecter device, the cable coupled thereto is retracted or paid out accordingly, each tool translation effecter device configured to selectively vary an active tension on the cable coupled thereto and to meter the cable as it is retracted and paid out.

10.-11. (Canceled)

12. (Previously Presented) A haptic device for operation by a user, comprising:

a user interface tool configured to be manipulated by the user and moved within a volume of space, and including a sensor array configured to detect at least one of roll, pitch, and yaw of the user interface tool;

a first, a second, a third, and a fourth tool translation effecter device, each coupled to a support structure in positions such that the first, second, third, and fourth tool translation effecter devices define between them a tetrahedron within the volume of space, each of the tool

translation effecter devices including a respective spool, a respective motor, and a respective encoder configured to provide a signal corresponding to rotation of the respective spool; and

a first, a second, a third, and a fourth cable each having a respective first and a respective second end, the first end of each of the first, the second, the third, and the fourth cables coupled to the user interface tool and the second end of each of the first, the second, the third, and the fourth cables wound and unwound on the spool of a respective one of the tool translation effecter devices, each of the motors operable to drive the respective spool to selectively apply active tension to the respective cable.

13. (Previously Presented) The haptic device of claim 12 wherein the sensor array is configured to detect roll, pitch, and yaw of the user interface tool.

14. (Currently Amended) The haptic device of claim 12, further comprising a processor system coupled to receive the signals from the respective encoders, the processor system configured to determine movement of the tool therefrom, to determine a force ~~response~~ vector to be applied to the user interface tool, and to determine an amount of active tension to be applied by the motor of each of the tool translation effecter devices to produce the determined force ~~response~~vector.

15. (Previously Presented) The haptic device of claim 14 wherein the processor system is configured to compensate for changes in effective diameter of the spools of the first, the second, the third, and the fourth tool translation effecter devices due to changing thickness of cable on each of the spools as the respective cable is wound and unwound from the respective spool.

16. (Canceled)

17. (Previously Presented) The haptic device of claim 12 wherein the processor system is configured to establish an initial position of the tool by retracting, in turn, each of the first, the second, the third, and the fourth cables to a known length position.

18. (Previously Presented) A haptic device for operation by a user, comprising:

a support structure;

a port coupled to the support structure;

a user interface tool configured to be manipulated by the user and moved within a volume of space, the user interface tool includes a tool shaft having a first and a second end, the tool shaft passing through the port such that the tool shaft pivots at the port and manipulation of the second end of the tool shaft is reflected in movement of the first end of the tool shaft;

a first, a second, a third, and a fourth tool translation effecter device, each coupled to the support structure in positions such that the first, the second, the third, and the fourth tool translation effecter devices define between them a tetrahedron within the volume of space, each of the tool translation effecter devices including a respective spool and a respective encoder configured to provide a signal corresponding to rotation of the respective spool; and

a first, a second, a third, and a fourth cable each having a respective first and a respective second end, the first end of each of the first, the second, the third, and the fourth cables coupled to the first end of the tool shaft and the second end of each of the first, the second, the third, and the fourth cables wound and unwound on the spool of a respective one of the tool translation effecter devices.

19. (Previously Presented) The haptic device of claim 18, further comprising:

a first sensor located at the port and coupled to the tool shaft, and configured to detect rotation of the user interface tool around an axis.

20. (Previously Presented) The haptic device of claim 18, further comprising:

a first sensor configured to detect rotation of the user interface tool around an axis, and a second sensor coupled to the second end of the tool shaft and configured to detect gripping force exerted by the user.

21. (Original) The haptic device of claim 18 wherein the second end of the tool shaft is configured to provide for the user a simulation of a selected tool.

22. (Original) The haptic device of claim 21 wherein the selected tool is formed as one of a stylus, a pen, a pliers, a wrench, a forceps, a scalpel, an endoscope, or an arthroscope.

23. (Original) The haptic device of claim 18, further comprising:

a feedback device coupled to the tool shaft and configured to selectively apply rotational force to the tool shaft.

24. (Original) The haptic device of claim 23 wherein the feedback device is located at the port.

25. (Original) The haptic device of claim 18, further comprising:

a feedback device coupled to the second end of the tool shaft and configured to selectively resist gripping force exerted by the user.

26. (Currently Amended) The haptic device of claim 14 wherein the processor system is configured to maintain a virtual environment within which the user interface tool is operated, and to apply the force ~~response~~ vector as feedback from the virtual environment to the user interface tool.

27. (Original) The haptic device of claim 14, further comprising:

a remote tool, and wherein the processor system is configured to control operation of the remote tool in accordance with the movement and orientation of the user interface tool.

28. (Currently Amended) The haptic device of claim 27 wherein the processor system is configured to apply the force ~~response~~ vector as feedback from the remote tool to the user interface tool.

29. (Previously Presented) A method, comprising:

applying a selectively variable active tension to each of a plurality of cables having respective first and second ends, each of the plurality of cables coupled at its respective first end to a tool, and at its respective second end to a respective anchor point;

measuring a change of cable length between the tool and each respective anchor point;

establishing an initial length of cable between the tool and each of the anchor points;

locking, during a shutdown procedure, each of the plurality of cables at the respective anchor point;

storing, after the locking and before completing the shutdown procedure, a value indicative of a known length of each of the cables in a memory; and

recovering the value indicative of the known length of each of the cables from the memory during a startup procedure.

30. (Original) The method of claim 29 wherein establishing an initial length of cable comprises moving the tool in turn to each of the anchor points such that the length of cable between the tool and the respective anchor point is effectively zero.

31.-32. (Canceled)

33. (Previously Presented) The method of claim 29 wherein establishing an initial length of cable comprises:

tracking a position of the tool independent of the measuring; and

correlating the position of the tool with known positions of the anchor points.

34.-37. (Canceled)

38. (Previously Presented) A method, comprising:

selectively applying active tension to each of four cables, each cable having a first end coupled to a tool and having a second end coupled to a respective vertex of a tetrahedron such that, as the tool is moved closer to any of the vertices the respective cables are drawn in at the respective vertices, thereby shortening the respective cables, and as the tool is moved away from any of the vertices the respective cables are fed out from the respective vertices, thereby lengthening the respective cables;

tracking changes in length of each of the four cables; and

deriving a change of position of the tool on the basis of tracked changes in length of each of the four cables.

39. (Previously Presented) The method of claim 38, comprising measuring rotation of the tool about one or more of three mutually perpendicular axes.

40.-41. (Canceled)

42. (Previously Presented) The haptic device of claim 13, further comprising a processor system coupled to receive information from the sensor array and coupled to receive the signals from the respective encoders, the processor system configured to determine movement and orientation of the tool therefrom.

43.-48. (Canceled)

49. (Previously Presented) The haptic interface device of claim 9 wherein each of the plurality of tool translation effecter devices is positioned relative to each other such that each tool translation effecter devices occupies a vertex of a tetrahedron.

50. (Previously Presented) The haptic interface device of claim 9 wherein each of the plurality of tool translation effecter devices includes a brake configured to lock the respective tool translation effecter device while the haptic interface device is powered down.

51. (Previously Presented) The haptic interface device of claim 9, further comprising:

establishing means for establishing, during an initialization procedure, a distance between each of the tool translation effecter devices and the attachment point.

52. (Previously Presented) The haptic interface device of claim 59 wherein the sensor array is configured to provide signals corresponding to each of a roll, a pitch, and a yaw of the tool.

53. (Previously Presented) The haptic device of claim 12 further comprising:

a first, a second, a third, and a fourth brake coupled to respective ones of the first, the second, the third, and the fourth tool translation effecter devices and configured, when engaged, to prevent rotation of the spools associated with the respective tool translation effecter devices.

54. (Previously Presented) The haptic device of claim 12 wherein the device comprises no more than four cables.

55. (Previously Presented) The method of claim 62, comprising:

locking, during a shutdown procedure, each of the plurality of cables at the respective anchor point;

storing a value indicative of a known length of each of the cables in a memory; and

recovering the value indicative of the known length of each of the cables from the memory during a startup procedure

56. (Canceled)

57. (Previously Presented) The haptic interface device of claim 1, comprising establishing means for establishing a respective distance between each of the first, the second, the third, and the fourth tool translation effecter devices and the attachment point.

58. (Previously Presented) The haptic interface device of claim 57 wherein the establishing means comprises a calibration point at which the attachment point can be positioned, and from which the respective distances between each of the first, the second, the third, and the fourth tool translation effecter devices and the attachment point are known.

59. (Previously Presented) The haptic interface device of claim 9, comprising a sensor array associated with the attachment point and configured to provide signals corresponding to at least one of roll, pitch, and yaw of the tool.

60. (Previously Presented) The method of claim 38, comprising establishing a length of each of the four cables by positioning the tool at a calibration point from which the respective lengths of each of the four cables is known.

61. (Previously Presented) The method of claim 38, comprising selecting a value of active tension applied to each of the four cables on the basis of a selected force response feedback to be applied to the tool.

62. (Previously Presented) A method, comprising:

selectively applying active tension to a cable having a first end and a second ends, the first end of the cable coupled to a tool and the second end of the cable coupled to an anchor point;

as the tool is moved closer to the anchor point, winding the cable onto a spool;

as the tool is moved away from the anchor point unwinding the cable from the spool;

tracking a distance of the tool from the anchor point by counting fractional rotations of the spool as the cable is wound and unwound therefrom; and

limiting tracking errors introduced by changes in effective diameter of the spool as the effective diameter changes in response to the cable being wound and unwound therefrom.

63. (Previously Presented) The method of claim 62 wherein the cable is one of a plurality of cables having respective first and second ends, the first ends coupled to the tool and the respective second ends coupled to respective anchor points, and further comprising:

winding each of the plurality of cables onto a respective spool as the tool is moved closer to the respective anchor point;

unwinding each of the plurality of cables from the respective spool as the tool is moved away from the respective anchor point;

tracking a distance of the tool from each of the respective anchor points by counting fractional rotations of each of the respective spools; and

limiting tracking errors introduced by changes in effective diameter of each of the respective spools as the effective diameter changes in response to the cable being wound and unwound therefrom.

64. (Previously Presented) The method of claim 62 wherein:

the number of cables in the plurality of cables is equal to three; and

the respective anchor points are positioned in a triangle that defines a plane in which the tool has freedom to move.

65. (Previously Presented) The method of claim 62 wherein:

the number of cables in the plurality of cables is equal to four; and

the respective anchor points are positioned at respective vertices of a tetrahedron positioned within a volume of space in which the tool has freedom to move.

66. (New) The haptic interface device of claim 1, wherein:

the force response is a force vector to be applied to the attachment; and

the calculating means is configured to calculate the force response according to the equation $J = (A\tau - f) + \alpha[\tau]^2$ by adjusting τ such that J is close to or equal to zero, where τ is a scalar representing magnitudes of force to be applied to the first, the second, the third, and the fourth cables, $A\tau$ is the force vector to be applied to the attachment point, f is a target force vector, and α is a stability coefficient.

67. (New) The haptic device of claim 14 wherein the processor system is configured to determine the amount of active tension to be applied using an optimization process to minimize an objective function.

68. (New) The haptic device of claim 67, wherein the objective function of the optimization process is a sum of (1) a difference between the force vector to be applied and a target force vector and (2) a product derived from a plurality of factors, at least one of which is the amount of active tension to be applied by the motor of each of the tool translation effecter devices.

69. (New) The method of claim 61 wherein the selected force response feedback is a selected force vector, and the selecting a value of active tension comprises optimizing, to be close to zero, a sum of (1) a difference between the selected force vector and a calculated target force vector and (2) a product, at least one factor of which is the values of active tension applied to each of the four cables.

70. (New) A method for controlling a haptic system, comprising:

determining a target force vector to be applied to the tool;

determining respective vectors of a plurality of cables coupled to a tool with respect to the tool;

determining respective tensions to be applied to the plurality of cables to apply an actual force vector to the tool, including balancing (1) a difference between the resulting actual force vector applied to the tool and the target force vector and (2) a magnitude of the tensions to be applied to the cables; and

applying the determined tensions to the respective cables to apply the actual force vector.

71. (New) The method of claim 70 wherein the balancing the (1) difference between the actual force vector and the target force vector and (2) the magnitude of the tensions comprises selecting the tensions to be applied to the plurality of cables such that the difference is close to or equal to a selected fixed value multiplied by the magnitude of the tensions.

72. (New) The method of claim 70 wherein the balancing the (1) difference between the actual force vector and the target force vector and (2) the magnitude of the tensions comprises selecting the tensions to be applied to the plurality of cables such that the difference is close to or equal to a selected fixed value multiplied by a squared value of the magnitude of the tensions.

73. (New) The method of claim 71 wherein the selected fixed value is a stability coefficient.